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PART II - REPORT

Design Study for 5000 h.p. Propellor Turbine
Prepared at KUPAVNO 1947-1948.

20. In March 47, the CHRISTIAN group initiated a design study for a novel propellor turbine of 5000 h.p. This power plant contained two independent turbines, one of two-stages to drive the compressor and a single stage turbine driving the propellor.

21. There are also two sets of independent annular combustion chambers. The first set is placed in the usual manner between the compressor and the two-stage turbine.

22. The second set of combustion chambers is placed behind this turbine and is fed by its exhaust, which still contains unburnt oxygen. Fuel is then injected into this second combustion chamber so as to raise the temperature of the gas to the same amount it possessed when entering the guide vanes of the two-stage turbine (820°C). At this temperature the exhaust enters the final single stage turbine geared to the propellor. The two turbines run on concentric shafts but are mechanically independent.

23. When the group left for KAZAN, all the engine components had been designed and working drawings were on the point of being made.

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Maximum Power	5000 shp. + 15% jet thrust (800 h.p.)
Specific fuel consumption	350 gm/bhp/hour
Engine RPM	7500
Mass air flow	24 kg/sec.
Compressor	Axial flow, 12 or 14 stages
Pressure ratio	6
Entry air speed	m/sec. 130
Exit air speed	m/sec. 180

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Combustor

Type	Two sets, annular.

Turbines
(Two on concentric shafts)

(a) Compressor drive - stages	2
(b) Airscrew drive - stages	1

Weight

kg	2,000 kg (complete, with airscrews)

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Dimensions

Overall length	m. 5
Maximum diameter	m. 0.75

Propellor

Type	contra rotating
No. of blades per prop	4
Prop diameter	cm. 550

24. Performance characteristics were calculated on the basis of the following assumptions:-

Compressor Efficiency	80% (adiabatic)
Combustion Chamber efficiency	97%
Turbine efficiency for both turbines	82%
Reduction gear efficiency	98%
Exit Jet efficiency	90%
Stagnation (total) temperature before inlet guide vanes (for both turbines)	820°C.

25. [redacted] according to CHRISTIAN the assumed component efficiencies were very conservative and that the estimated specific fuel consumption (340 gm. per B.h.p. hour) would be considerably reduced as soon as some development work had been done. The main advantage of the design consists of course in the very small overall diameter and consequent reduction in air drag. 25X1

ZAVOD 16 (KAZAN) (July 48 - July 50)

26. After completing the design study at KURAKINO the CHRISTIAN group was transferred to KAZAN where a "Special Design Office" (OKB) had been set up in the grounds of ZAVOD 16. The CHRISTIAN project was studied in great detail by the MVD (KOLOSOV) and others over the period August 48 to Feb. 49. During this same period, informant was able for the first time to do some experimental work.

27. He thus carried out some spray tests with Kerosene using duplex fuel jets of the L'Orange type and later investigated the combustion efficiency of a modified BMW annular chamber (primary and secondary air mixing downstream). Tests were carried out using one and three sections of the ring only (not a complete chamber), the efficiency being measured by jet reaction. Other members of the team carried out temperature measurements. The German experiments were carried out in one bay of a large house containing at least ten stands which were occupied most of the time. [redacted] the other stands [redacted] dealt with Nene engines. 25X1 25X1

28. At the end of this period, the Russians finally turned down the original CHRISTIAN project. From Feb. 49 to July 50, an alternative design for a propellor turbine with only one set of combustion chambers was built by the Russians.

29. Though not directly concerned with the testing schedule, [redacted] this engine had a ten-stage compressor and a two-stage turbine mounted on a rigid shaft. Considerable trouble was experienced and the engine never developed more than 3,500 s.h.p. although designed for 5,000 s.h.p. During this period the CHRISTIAN group did virtually nothing. There was also talk of imminent repatriation, now the group had been [redacted] 25X1 25X1

Aero-Engine Production at KAZAN

30. Rigid security precautions at ZAVOD 16, KAZAN, made it impossible for the Germans to enter the factory area [redacted] 25X1

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during 1949 [redacted] the BMW 003, [redacted] 25X1
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[redacted] This identification was confirmed by the characteristic 25X1
sound of the Riedl starter of the 003 under test which was heard sufficiently regularly to suggest quantity production of this unit. During 1949-50 the Germans, who discussed the subject in their off-time, were of the opinion that ZAVOD 16 was also producing the "Nene".

ZAVOD II, KUIBYSHEV (July 1950-Dec. 53)

31. Dr. Manfred CHRISTIAN accompanied the KAZAN group to ZAVOD II, KUIBYSHEV, where it was disbanded for integration into the existing JUNKERS/BMW development team. Feeling ran high in the group which had expected early repatriation after completing the KAZAN project in July 1950.

32. In August CHRISTIAN supported by some of his colleagues refused to work unless the question of repatriation was seriously considered by the Soviet authorities. Though he resumed work a few days later with the others, CHRISTIAN continued to ventilate his grievances to the embarrassment of the group. A second refusal to work in September by CHRISTIAN, JORDAN and [redacted] was countered by MVD intervention which resulted in the arrest of CHRISTIAN a few days later. 25X1

33. [redacted] CHRISTIAN's arrest 25X1
was not due so much to the failure of the propellor turbine designed at KURAKINO and KAZAN as to CHRISTIAN's indiscreet criticisms of Soviet treatment of German specialists detained in the USSR against their will.

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[redacted] carried out combustion chamber efficiency 25X1
tests for the 022 propellor turbine under BAHN. Two sections only of the annular chamber were tested using an air flow of 3 kg/sec. obtained from the compressor of a modified 022 engine operating as a pure jet. The combustion efficiencies were calculated from the thrust obtained.

35. [redacted] criticism of the original CHRISTIAN project and of the 25X1
lack of specialised knowledge of the group was confirmed [redacted] what had 25X1
been achieved at KUIBYSHEV by the JUNKERS/BMW team over the period 1946/50. In his opinion, the 022 engine achieved in a thoroughly practical form what the CHRISTIAN group had failed to do. It must however be admitted that the facilities placed at the disposal of the Germans by the Russians were much greater at KUIBYSHEV than at KAZAN.

[redacted]

37. [redacted] form a good overall picture of the develop- 25X1
ment work carried out on the 022 [redacted] this engine 25X1
as a thoroughly practical proposition as long ago as 1951/52. In the case of 25X1
the 'K' project (10,000 h.p. turbo-prop) [redacted] since the 25X1
test schedule for this engine was entirely in Russian hands.

38. Performance and Physical Characteristics of 022 (Project 'A') Propellor Turbine

Power	- SHP	5000 plus 500 kg jet thrust.
Engine speed	- RPM	7500-7600
Mass air flow	- Kg/sec.	30
Compressor		axial flow 14-stage.
Compressor efficiency		88% (adiabatic)
Combustion chamber		can-annular
Comb. chamber efficiency		97%
Turbine		3-stage
Turbine efficiency		90%

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39. On static test during 1950/51, by which time teething troubles had been eliminated, specific fuel consumption figures of the order of 240 gm/b.h.p./hr. were recorded.

It is important to note in this connection that all tests were carried out with graphite or brass blocks fitted inside the turbine casing to reduce blade tip clearance. [redacted] these were extremely susceptible to fracture or gas erosion and were a limiting factor when considering engine life. 25X1 25X1

40. By 1952 static testing was all but completed at ZAVOD II [redacted] the 022 was flight tested, though no data was ever released to the Germans. 25X1 25X1

Project 'M'

41. On Russian orders two 022 engines were coupled to form a 10,000 s.h.p. power unit driving contra-rotating propellors. Since the output of this unit known as Project 'M' was almost identical with that of the 'K' engine, then in the design study stage, it was generally believed that the Russians required such an engine as quickly as possible for flight tests to study the possibilities of propellor turbines on very large aircraft. Several of these conversions were made and informant is confident that they were flight tested.

Project 'K'

42. Run on the water brake in March 1953 and airscrew tested later in the year, the 'K' turbo-prop was designed to develop 10,000 shaft h.p. with a specific fuel consumption of 240 gm/h.p./hr. (at 8200 r.p.m.). According to German engineers associated with the project, the design was sound and the development likely to be more rapid than that of the 022 since many of the proven features of the latter were incorporated in the larger engine.

43. Like the 022 the 'K' had blocks fitted inside the turbine casing at all stages to reduce blade tip loss. Though a so-called supersonic (transonic) compressor was tested at KUYBYSHEV the 'K' as finally built had a normal 14-stage axial flow compressor.

44. Unlike the 022, the 'K' was designed entirely at ZAVOD II and there was no question of adapting an existing JUNKERS or BMW project. A 14-stage compressor (mass air flow 60 kg/sec.) was used with the can-annular combustion chamber layout of the 022 and a 5-stage turbine coupled by a rigid shaft driving the compressor and airscrew reduction gear.

45. In March/May 1954 the 'K' was run successfully on the water brake and airscrew testing began in June-July of the same year when S.F. consumptions of the order of 250 gm/b.h.p./hr. were recorded. The test stands were by now regarded as a Russian preserve, only Dipl. Ing. Alfred GRIMM, chief test stand engineer, being allowed to take part in the testing schedule of the 'K'.

[redacted] 25X1

46. From members of the JUNKERS and BMW groups [redacted] the Germans deported in 1946 had done much to improve the equipment at ZAVOD II before his arrival, but there was no doubt that the establishment had all the facilities expected of a modern aero-engine research and development centre. 25X1

47. [redacted] a fourth test bed was built with provision for simultaneous torque and thrust measurements. Before the 'K' was tested a water brake to absorb 15,000 h.p. was constructed in 1951/52. [redacted] 25X1 [redacted] the KUYBYSHEV centre was a permanent establishment which would be maintained after the withdrawal of the Germans. 25X1

48. Of the accessories seen at KUYBYSHEV, [redacted] the TS-1 turbo-starter the most interesting. He was sure that it was in series 25X1

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production by 1952 when there was no supply difficulty in obtaining the starter for use with the 022. When the design study of the 014 was prepared at KIMRY-SAVELOVO it was assumed that the TS-1 would be fitted. A modification of the TS-1 with increased output was used for the 'K' turbo-prop. [redacted] 25X1 such an engine starter carried on the aircraft is essential 25X1 if a quick take-off of a large number of aircraft is to be undertaken.

KIMRY-SAVELOVO (USSR) (Dec. 53-June 54)

49. By July 1954 most of the German engineers and designers had been withdrawn from co-ordinated development work in preparation for their transfer to KIMRY-SAVELOVO in December of that year. Some work was done at SAVELOVO in a design study for a turbo-jet of 3000 kg. maximum thrust to power a high performance civil aircraft.

50. Designated the 014, this engine was to be a single shaft axial-flow turbo-jet with a twelve stage compressor (mass air flow 30 kg/sec.) and three-stage turbine using the proven combustion chamber layout of the 022A series. The design incorporated all the successful features of the 022A developed at KUIBYSHEV, including accessories such as the TS-1 (Cyrillic designation TC-1) turbo-starter, fuel pumps and lubrication system.

PART III - PERSONALITIES

51. KOLOSOV - Russian director of OKB at KAZAN.

KUZNETSOV - Head of Design office at ZAVOD II, KUIBYSHEV.

OVCHAROV - Russian, Chief Test Stand Engineer. Worked with Dipl. Ing. Alfred CRIEM.

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